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ABSTRACT

The learning efficiency and effectiveness of teaching an anatomical and physiological system to Air Force enlisted trainees utilizing an experimental audiovisual programed module was compared to that of a commercial linear programed text. It was demonstrated that the audiovisual programed approach to training was more efficient than and equally as effective as the programed text approach to training. It was determined that trainees of different learning abilities acquired as much knowledge about the digestive system from viewing the 20-minute audiovisual module as from interacting for 80 to 120 minutes with the programed text. It was established that students who differed in their mastery of the rudiments of anatomy, physiology, and medical terminology performed equally well after audiovisual instruction or after writte programed instruction. It was found that trainees reported more positive reactions to the audiovisual course than to the written program. (Author/JY)

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EVALUATING AN EXPERIMENTAL AUDIO-VISUAL MODULE PROGRAMMED TO TEACH A BASIC ANATOMICAL AND PHYSIOLOGICAL SYSTEM

By

Pat-Anthony Federico, 1st Lt, USAF

Technical Training Division
Lowry Air Force Base, Colorado

July 1971

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AIR FORCE HUMAN RESOURCES LABORATORY

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TECHNICAL TRAINING DIVISION
AIR FORCE HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND
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FOREWORD

This study represents a portion of the in-house research program of Project 1121, Technical Training Development; Task 112101, Advanced Technology for Air Force Technical Training. Dr. Marty R. Rockway was the Project Scientist and Mr. Joseph Y. Yasutake was the Task Scientist. The report covers research performed between May 1970 and September 1970.

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This technical report has been reviewed and is approved.

George K. Patterson, Colonel, USAF
Commander

ABSTRACT

This study evaluated the learning efficiency and effectiveness of teaching an anatomical and physiological system to Air Force enlisted trainees utilizing an experimental audio-visual programmed module and a commercial linear programmed text. It was demonstrated that the audio-visual programmed approach to training was more efficient than and equally as effective as the programmed text approach to training. It was determined that trainees of different learning abilities acquired as much knowledge about the digestive system from viewing the 20-minute audio-visual module as from interacting for 80 to 120 minutes with the programmed text. It was established that students who differed in their mastery of the rudiments of anatomy, physiology, and medical terminology performed equally well after audio-visual instruction or after written programmed instruction. It was found that trainees reported more positive reactions to the audio-visual program than to the written program. It was recommended that within the Medical Service Fundamentals Course audio-visual programmed instruction be emphasized and written linear programmed instruction be de-emphasized.

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SUMMARY

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Problem

Air Force enlisted medical and dental personnel begin their training with the Medical Service Fundamentals Course at the Medical Service School (MSS), Sheppard Air Force Base, Texas. Included in the core curriculum are units of instruction planned to teach rudiments of medical terminology, anatomy, and physiology. Currently, MSS is using a linear programmed text to teach these subjects which are needed as a basis for understanding structures and functions of major mechanical and chemical systems of the human body. Despite precautions taken by the author of this text, training managers at the MSS were concerned that some of their less literate trainees were having difficulty following the programmed text. It was thought that students were not given sufficient exposure to audio-visuals to enable them to view subject matter in an integrated way, or to understand its overall organization. The primary purpose of this study was to determine whether a newly developed audio-visual programmed module was more effective and efficient than the currently used programmed text for teaching an instructional segment on the digestive system in the course. A secondary purpose was to estimate student opinions and reactions to this audio-visual programmed approach of teaching this system, as opposed to the written programmed approach.

Approach

An audio-visual programmed module was developed to teach the rudiments of the digestive system. It consisted of synchronized 35mm color slides and an audio-visual tape; and it covered the same enabling objectives as the corresponding chapter from a linear programmed text. However, the script was not as redundant as the written programmed material. Air Force enlisted trainees had been randomly and previously placed into four classes; and educational media were randomly assigned to these classes according to a Solomon four-group experimental design. Statistical comparisons of the groups were made in terms of posttest performance. Also, a theme analysis was conducted of student reactions and opinions toward the audio-visual program and written program.

Results

It was demonstrated that the audio-visual programmed approach to training was more efficient than and equally as effective as the programmed text approach. It was possible to reduce the duration of a lesson as much as 75 to 83 percent while still maintaining its effectiveness by using a minimally redundant audio-visual instructional module. Trainees of different intellectual abilities acquired as much knowledge about the digestive system from viewing the 20-minute audio-visual module as from interacting for 80 to 120 minutes with the programmed text. Students who differed in their mastery of the rudiments of anatomy, physiology, and medical terminology performed equally well after audio-visual instruction or after written programmed instruction. Trainees reported more positive reaction to the audio-visual program than to the written program.

Conclusions

In view of the findings, it was recommended that within the Medical Service Fundamentals Course the utilization of audio-visual programs be maximized and the utilization of written programs be minimized.

This summary was prepared by Pat-Anthony Federico, Technical Training Division, Air Force Human Resources Laboratory.

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EVALUATING AN EXPERIMENTAL AUDIO-VISUAL MODULE PROGRAMMED TO TEACH A BASIC ANATOMICAL AND PHYSIOLOGICAL SYSTEM

I. INTRODUCTION

Air Force enlisted medical and dental personnel begin their training with the Medical Service Fundamentals Course, taught at the Medical Service School (MSS), Sheppard Air Force Base, Texas. Included in the core curriculum of this course are units of instruction planned to teach the rudiments of medical terminology, anatomy, and physiology. Currently, MSS is using a linear programmed text to teach these subjects which are needed as a basis for understanding the structures and functions of the major mechanical and chemical systems of the human body. Despite the precautions taken by the authors of this text (GPTC, 1964), there may be an exaggeration of the deficiencies of linear programs within this course environment. Some of the inherent inadequacies of written linear programs may be intensified because of variability among trainees in their intellectual abilities, aptitude levels, and reading skills. By using a very verbal programmed text to teach these students, the effectiveness of instruction is extremely dependent upon the literacy skills of individual students. Consequently, training managers at MSS were concerned that some of their less literate trainees were having difficulty following the programmed text. One solution suggested to overcome this literacy problem was to reduce the requirement for reading skill through the use of a well-designed audio-visual instructional program. Within the context of the current training program, it was thought that students were not given sufficient exposure to audio-visuals to enable them to view the subject matter in an integrated way, or to understand its overall organization. It seemed likely, however, that an appropriate audio-visual module might provide a frame of reference which would make it easier for students to associate technical terms with the anatomical structures and physiological functions they signify.

There is considerable support within psychological and educational literature for suggesting the use of audio-visual media in this context. It has been stated that there are several intrinsic insufficiencies in many written linear programs. Four essential features characterize these programs. Firstly, the subject matter is broken up into small units which are presented to the student in a linear fashion by successive frames. Secondly, after answering the first question (or filling in one or more blanks in a statement), a check-answer is presented to the student within the same frame or within the next sequential frame where a new unit and question appear. Thirdly, this procedure is mechanically repeated to the end of the program. Fourthly, there is no provision for varying the linear sequence except by repetition of a set of frames prior to proceeding to the next set. For example, Skinner (1954, 1958) prescribed the following features for effective teaching programs: the step-by-step procedure, the active constructed response required of the learner, the prompt reinforcement of every response provided by the check-answer, and the self-pacing permitted by the program.

According to Smith and Smith (1966), one of the most serious deficiencies of Skinnerian programs is the restricted nature of the material they present. That is, these programmed texts make almost no use of nonverbal displays and other supplementary aids. Teaching a course by a written linear program is deliberately limiting the media of communication, the experiences of the student, and consequently, the range of understanding he achieves. Some researchers and educators (Pressey, 1963; Smith & Smith, 1966) believe that the most promising approach to training is to provide the student with a broad context of experience by resorting to the great gamut of gadgets employed as communicative media. If learning consists of an association of many, different, multimedia stimuli and responses, then the fixed-sequence, constructed-response, arbitrarily simplified, bit-by-bit, linear frames of a Skinnerian programmed text are insufficient, and may not even be necessary, for efficient and effective learning.

Linear programming tends to emphasize the articulation of material in terms of its detail. In so doing, it constructs no general context. There are few bodies of knowledge that do not lose some meaning and significance if presented automatically as a series of discrete steps. It appears to be almost impossible for a conventional Skinnerian program to teach the broader aspects and meanings of a subject, since programming stresses juggling of verbal units, rather than integrating verbal presentations with visual displays, demonstrations, and direct experiences.

According to Pressey (1963), new instructional material should not be initially presented to a trainee in a bit-by-bit fashion in a programmed text, but rather in a larger, more meaningful whole. For the first go-through or the final review, discrete programs are unsatisfactory. One of the most important aspects of new material to be learned is its structure. Detailed programming destroys most of this except the serial order. Similarly, Smith and Smith (1966) stated:

> A Skinnerian program makes no provision for manipulating the material in flexible ways to discover unusual relationships and varied meanings. When linear, small-step programs are used, the learner's performance may take on the characteristics of a vigilance task, in which restrictive sensomotor conditions prevent effective feedback control. Such programs reduce the possibilities for individualized control over the learning situation by rigidly restricting the activities of the learner to a series of discrete responses. Such monotonous design can be justified only for practice on discrete unitary items, such as spelling words, and then not for too long a period. . .
>
> Inasmuch as linear programs are thought by Skinnerians to be analogous to an operant conditioning sequence, no thought is given to their spatial reference systems. The questions and answers compose a temporal series of discrete units, and few, if any, organized perceptual displays are given the student to help him understand the over-all organization of the subject matter. Thus for material that has inherent logical structure, a linear program is a poor teacher. Audio-visual teaching machines have some advantages over restricted verbal programs in that they can display graphs and illustrations to give spatial reference to the verbal material (p.295).

Audio-visuals, textbooks, demonstrations, experiments, lectures, and other diversified presentations aid in establishing a frame of reference against which new material can be embedded, thus enhancing its meaning. Paradoxically, writers of programmed texts eliminate from frames as "extraneous" material which should often be included in order to provide as rich a context as possible. Presenting a new subject in diverse, interesting ways increases the transfer potential of the learned material. One way to insure the transferability of what has recently been acquired is to vary the conditions of learning. An attempt is made to do this in programmed texts by including general rules and examples, and by endeavoring to vary the wording in frames. However, these programs are still very restricted when compared with the many different aural and visual, verbal and nonverbal techniques of the classroom.

Several researchers (Briggs & Naylor, 1962; Kendler, 1959; Krumboltz & Weisman, 1962; Nunn, 1961) have suggested that limited linear programs teach equally limited knowledge. They implied that to teach a rigid system of specific responses, a written linear program may do the job. But to educate in a broader sense, a variety of media, a diverse approach, and a potential for flexible responses on the part of the learner are the mandatory minimum. Only in these ways can the student's frame of reference be varied enough to assist in the transfer of what has been learned to help solve newly encountered problems. Generally, it has been concluded that graphic-verbal means of communication are better than verbal alone; it has been demonstrated that films, sound-slide programs, and other audio-visual devices are equivalent to an average teacher in some cases (Smith & Smith, 1966). It should be emphasized that these findings have not been established universally, for there are very many variables in audio-visual materials, in the students, and in the teaching-responding situations, to name only a few, that effect the learning that occurs. The primary purpose of the present study was to determine whether a newly developed audio-visual programmed module was more effective and efficient than the currently used programmed text for teaching an instructional segment on the digestive system in the Medical Service Fundamentals Course at Sheppard Air Force Base. A secondary purpose was to estimate student opinions and reactions to this audio-visual programmed approach of teaching this system, as opposed to the written programmed approach.

II. METHOD

Subjects

The subjects were 112 Air Force enlisted trainees enrolled in the Medical Service Fundamentals Course, 3AQR90010, at Sheppard Air Force Base, Texas. These subjects were randomly assigned to one of four classes designated Class 1 (n = 25), Class 2 (n = 21), Class 3 (n = 24), and Class 4 (n = 42), respectively. Several test scores were available for each of the subjects: Armed Forces Qualification Test (AFQT); Airmen Qualifing Examination: General (AQE Gen), Administrative (AQE Admin), Electrical (AQE Elec), and Mechanical (AQE Mech); Quickword Test (Quickword), a short intelligence test (Borgatta &

Corsini, 1964); and Week-one Anatomy and Physiology Test (Wk-1 Anat&Phys). This latter test (Wk-1 Anat&Phys) is given at the completion of the first week of the Medical Service Fundamentals Course; it was written by the instructors at MSS to test these enabling objectives: elementary medical terminology, anatomy, and physiology.

Instructional Media

The instructional media employed in this study were a commercially developed Skinnerian programmed text and an experimental audio-visual programmed module. Specifically, the written programmed material consisted of 38 pages from Chapter 7, The Digestive System, *The Human Body and Its Function: A Programmed Course,* (GPTC, 1964); the audio-visual programmed material consisted of synchronized 35mm color slides and an audio tape. The slide projector used was a Kodak Carousel, Model 850; the reel tape player-recorder used was a Roberts sound-with-sound model 1650. The pulses to automatically change slides were placed on the audio tape with a Kodak Carousel Sound Synchronizer, Model 2. Of the 25 slides, approximately three-quarters were obtained from the CIBA Collection of Projection Slides of Medical Illustrations by Frank H. Netter, MD. (These slides, and others, were made available at no charge for this study by the CIBA Pharamaceutical Company, Summit, New Jersey.) The contents of other slides in the series were drawn by professional illustrators. Also, these additional illustrations were photographed, developed, and mounted as 35mm projection slides by photographic personnel of the Air Force Human Resources Laboratory. The script for the audio track was written, read, and recorded by TSgt Ozrow A. Ellis, Jr. of the MSS; it covered the same enabling objectives as the programmed chapter. However, the script (see Appendix 1) was not as redundant as the written programmed material. An effort was made to stimulate active student participation in this audio-visual module. This was attempted by requiring trainees to respond overtly to questions asked on the audio tape regarding the contents of specific slides. Participation required of the trainees was induced in order to somewhat match the participation demanded of the students by the programmed chapter.

Procedure

All four classes began the Medical Service Fundamentals Course using only the programmed text. They had completed the first six chapters of this text covering sequentially the Organization of the Human Body, the Skeletal System, the Muscular System, the Nervous System, the Circulatory System, and the Respiratory System. Completion of this material required response to each of the first 99 pages of the programmed text. All of the students had finished this task in the seven hours of classroom time allotted. The trainees responded to the written program for two hours in the afternoon of the first day of the course; they received a 10-minute break between these classroom hours. Most of the second day was devoted to following the text. This resulted in approximately five hours of interacting with the programmed text since one-sixth of daily scheduled classroom time was set aside for student breaks. Each of the four classroom instructors was requested not to assist his students, or make any comments to them about the subject matter during this time.

Fig. 1. **Representation of the Solomon four-group experimental design adopted for the study.**

	Treatment		
Class	Pretest	Programmed Medium	Posttest
1	X	Audio-visual	X
2	X	Written text	X
3		Audio-visual	X
4		Written text	X

This study was conducted during most of the morning of the third day of the course. It involved randomly assigning the educational media to classes according to a Solomon four-group experimental design. The advantages derived from employing this experimental scheme have been discussed by Cambell and Stanley (1963). The specific assignment of the different media, the pretest, and the posttest to the classes is depicted in Figure 1. The pretest given to two classes randomly selected, and the posttest given to all four of the classes, are presented in Appendixes II and III, respectively. These tests which measured course enabling objectives were scored by awarding one point for each correct answer; thus, the highest scores possible were 50 and 25 for the pretest and posttest, respectively. Class 2, the pretest-posttest control group, was initially given a pop-quiz at 0800 covering the first seven chapters of the programmed test. They were allowed 60 minutes to complete this test, fifty percent of

which dealt exclusively with the digestive system. Following a 20-minute break, they were instructed to complete Chapter 7, the Digestive System, and to be prepared for a test on the material immediately following the task. Subsequent to the instructions, the trainees began responding to this program; all trainees covered the chapter within 80 to 120 minutes. The instructor administered the posttest to each student within 3 minutes after he finished responding to the program, allowing 30 minutes to complete the posttest. Upon conclusion of this task, students were requested to make written comments, during the next 15 minutes, expressing their own opinions and reactions toward using a programmed text to learn anatomy, physiology, and medical terminology of the digestive system. Class 4, the posttest-only control group, was not given the pretest covering the first seven chapters of the programmed text. Otherwise, they followed the same procedure as Class 2, beginning with Chapter 7 at 0900. Class 1, the pretest-posttest experimental group, followed essentially the same procedure as Class 2. However, they covered the digestive system material by viewing, as a group, the sound-slide program. The duration of this audio-visual instruction was 20 minutes. The time intervals between the pretest and the sound-slide program, and the sound-slide program and the posttest, were the same as those for Class 2. Also, this class was requested to make written comments expressing their own opinions and reactions toward observing the audio-visual programmed module to learn the anatomy, physiology, and medical terminology of the digestive system. Class 3, the posttest-only experimental group, followed essentially the same procedure as Class 4. However, they covered the digestive system material viewing, as a group, the audio-visual program. The four instructors monitored their respective classes throughout the sound-slide showing or the programmed chapter responding. They were instructed not to make any comments about the digestive system to their students while, or immediately after, they viewed or interacted with the material.

III. RESULTS

Effect of Media

The means and standard deviations of test scores for the sample of enlisted medical trainees are presented in Appendix IV, Table 8; the intercorrelation matrix of these test scores is given in Appendix IV, Table 9. A summary of the Wherry-Doolittle Method for computing multiple correlation (Guilford, 1965), using the posttest as a criterion variable, is presented in Appendix IV, Table 10. Note that for this entire sample of 112 students, the optimum concomitant variables of in-class performance as measured by the criterion were Wk-1 Anat&Phys, Quickword, AQE Gen, AFQT, and AQE Mech, respectively. This multiple regression analysis was computed primarily to determine the best covariates of the criterion among all the test scores available for these trainees.

Table 1. **Means and Standard Deviations of Pretest and Posttest Scores for the Classes**

		Pretest		Posttest	
Class	N	Mean	SD	Mean	SD
1	25	32.4399	5.3576	19.5200	3.2676
2	21	33.7500	5.6480	20.8571	2.1514
3	24			19.6666	3.2660
4	42			18.9286	3.8279

In Table 1 are the means and standard deviations of pretest scores for Classes 1 and 2, and the posttest scores for Classes 1 through 4. Using as covariates those test scores which were found by the multiple regression analysis to be concomitant to posttest performance, a two-by-two factorial analysis of covariance was calculated for the criterion scores. One factor was defined as pretesting, its occurrence or nonoccurrence for classes; the other factor was defined as programmed media, audio-visual or text. The regression coefficients of tests found to covary with posttest performance and their respective t values are shown in Appendix IV, Table 11. A summary of the analysis of variance of posttest scores for this factorial analysis of covariance is exhibited in Table 2. Note that neither the main effect of pretesting nor its interaction was found to be significant. It can be concluded, then, that the pretest was not reactive in terms of sensitizing Classes 1 and 2 to the material that was to be covered on the posttest. Consequently, the results obtained for the pretested classes could be considered as representative of the effects of the experimental factor, media, for the unpretested classes as well.

Since this generalization was possible (due to the findings of the preceding factorial analysis of covariance), a one-way analysis of covariance, with media the criterion of classification, was computed using the scores of students in the pretested

Table 2. **Analysis of Variance Table of Posttest Scores for the Factorial Analysis of Covariance, Stratified Variables: Pretest and Programmed Medium**

Source of Variation	df	MS	F*
Pretest (P)	1	5.8513	.8749
Programmed Medium (M)	1	22.4924	3.3630
P x M	1	.6789	.1015
Residual	75	6.6882	

Note. — Covariates used in this analysis are those concomitant variables presented in Appendix IV, Table 11. Acquisition time was not used as a covariate in this analysis and other reported relevant analyses since this measure was affected by the experimental treatments. Had any of the F ratios been significant, it would not have been possible to conclude validly that the experimental treatments had differential effects (Lindquist, 1956).

*$p > .01$.

classes, Classes 1 and 2, only. Multiple covariates, including pretest scores, were used in this analysis. These covariates together with their regression coefficients, standard errors, and *t* values are given in Appendix IV, Table 12. The one-way analysis of covariance indicated that there were no significant differences among class-posttest scores after adjusting with those covariates reported in Appendix IV, Table 12. The means, adjusted means, and standard errors of the posttest scores for pretested Classes 1 and 2 are presented in Table 3. It can be concluded then that the 20-minute audio-visual programmed module taught the digestive system equally as well as the chapter from the programmed text which took students anywhere from 80 to 120 minutes to complete. Needless to say, a very substantial saving was realized by bringing Class 1, in approximately one-fourth to one-sixth the time, to a plateau of performance which did not differ from that of Class 2. These results showed that it was possible, by using a minimally redundant audio-visual instructional module, to reduce the duration of a lesson by as much as 75 percent to 83 percent, while still maintaining its effectiveness.

Intellectual Abilities and Media

Subjects were also sorted into high and low AFQT groups according to whether or not their scores were above or below the median on this test for this specific sample, 62.5. Subsequently, within each of these AFQT groups, subjects were divided into audio-visual and written text subgroups, according to the programmed media they received. This classification scheme resulted in four other groups from which trainees were randomly discarded in order to produce an equal number of subjects per group ($n = 20$). The means and standard deviations of the posttest scores for these groups are shown in Table 4. Regression coefficients and their respective *t* values for tests concomitant to the posttest performance of the four groups are given in Appendix IV, Table 13. Using as covariates those tests tabulated in Appendix IV, Table 13, a two-by-two factorial analysis of covariance was computed for posttest scores. One of these factors was defined as AFQT, high versus low; the other factor was defined as programmed media, audio-visual versus text. A summary of the analysis of variance of posttest scores for the factorial analysis of covariance is presented in Table 5. As can be seen, neither the main effect nor the interaction source of variation was found to be significant. Postulating that pretest equivalence of these four groups of subjects was approximated by randomization, additional information was obtained, from the results of this analysis, regarding the performance of trainees on the posttest. Namely, the high and low AFQT groups did not differ in their levels of achievement. Further, the high and low AFQT subgroups which viewed the audio-visual program did not differ in their degree of attainment from the high and low AFQT subgroups which responded to the written program. Trainees, then, who differed somewhat in their basic intellectual abilities (verbal, numerical, spatial, or mechanical) as measured by the AFQT, learned as much about the digestive system from the audio-visual programmed module as from the programmed text.

Medical Rudiments and Media

Trainees were further categorized into high and low Wk-1 Anat&Phys groups according to whether or not their scores were above or below the median on this test for this sample, 47.5. Within each of these Wk-1 Anat&Phys groups, subjects were sorted into audio-visual and text subgroups according to the programmed media they received. This classification scheme produced four new groups from which trainees were randomly discarded in order to form an equal number of subjects per group ($n = 23$). The means and standard deviations of posttest scores for these groups are tabulated in Table 6. Regression coefficients and their associated *t* values for tests

Table 3. **Means, Adjusted Means, and Standard Errors of Posttest Scores for Pretested Classes**

Class	Class Mean	Adjusted Mean	SE Adjusted
1	19.5200	19.5650	4.8125
2	20.8571	20.7939	5.4216

Note.—A one-way analysis of covariance with multiple covariates, including pretest scores, indicated that there were no significant differences among class posttest scores after adjusting with those covariates reported in Table 5 (Adjusted MS between Classes = 1462.7539; $F(1, 38) = 2.6910$; $p > .01$).

Table 4. **Means and Standard Deviations of Posttest Scores for Groups Classified According to AFQT Scores and Programmed Medium**
(n = 20)

AFQT Group	Audio-visual		Written text	
	Mean	SD	Mean	SD
High	20.8999	2.6137	19.7000	2.9037
Low	18.0499	3.0344	18.7999	4.0471

Note.—Subjects were classified into high and low scoring groups according to their scores on the AFQT relative to the median for this sample, 62.5.

Table 5. **Analysis of Variance Table of Posttest Scores for the Factorial Analysis of Covariance, Stratified Variables: AFQT and Programmed Medium**

Source of Variation	df	MS	F*
Programmed Medium (M)	1	6.6223	.8634
AFQT (Q)	1	.0559	.0073
M x Q	1	27.7048	3.6121
Residual	73	7.6670	

Note.—Covariates used in this analysis are those presented in Appendix IV, Table 13.

*p > .01.

concomitant to posttest performance of these four groups are presented in Appendix IV, Table 14. Using as covariates those tests reported in Appendix IV, Table 14, another two-by-two factorial analysis of covariance was calculated for posttest scores. One of these factors was specified as Wk-1 Anat&Phys, high versus low; the other factor was specified as programmed media, audio-visual versus text. A summary of the analysis of variance of posttest scores for this factorial

Table 6. **Means and Standard Deviations of Posttest Scores for Groups Classified According to Week-One Anatomy and Physiology Test Scores and Programmed Medium**
(n = 23)

Wk-1 Anat&Phys Group	Audio-visual		Written text	
	Mean	SD	Mean	SD
High	20.9130	2.9987	21.0869	2.6097
Low	18.1739	3.0697	18.3478	3.2278

Note.—Subjects were classified into high and low scoring groups according to their scores on the Week-One Anatomy and Physiology Test relative to the median for this sample, 47.5.

Table 7. **Analysis of Variance Table of Posttest Scores for the Factorial Analysis of Covariance, Stratified Variables: Week-One Anatomy and Physiology Test and Programmed Medium**

Source of Variation	df	MS	F*
Wk-1 Anat&Phys (W)	1	29.0085	3.6584
Programmed Medium (M)	1	6.0872	.7677
W x M	1	.0027	.0003
Residual	85	7.9293	

Note.—Covariates used in this analysis are those presented in Appendix IV, Table 14.

*p > .01.

analysis of covariance is given in Table 7. In this table, too, it can be seen that neither the main effect nor the interaction source of variation was significant. Again assuming that pretest equivalence of these four groups of subjects was approximated by randomization, the analysis produced further information concerning the trainees' posttest performance. It indicated that high and low Wk-1 Anat&Phys groups did not differ significantly in their posttest scores. Also, the high and low Wk-1 Anat&Phys subgroups which received the audio-visual module did not differ in their level of achievement from the high and low Wk-1 Anat&Phys subgroups which received the programmed text. It can be stated that students who differed to some extent in their mastery of the rudiments of anatomy, physiology, and medical terminology, as measured by the Wk-1 Anat&Phys test, demonstrated as much knowledge about the digestive system after seeing the sound-slide program as after responding to the written program.

14

Theme Analysis of Reactions Toward the Media

Analysis of student reactions and opinions toward the audio-visual program and the written program, expressed in their critiques, revealed several predominant themes. On the positive side, trainees expressed that they liked watching the audio-visual programmed module better than following the programmed text. This was so because, in their opinion, the written program was repetitious and redundant. That is, by using the text they had to keep reading the same material over and over again. The students found this very monotonous and tedious; whereas, they felt that the audio-visual instruction went directly to the point of what should be learned. Consequently, the trainees thought that the sound-slide program helped them to acquire the material more easily. Also, they asserted that this kind of instruction keeps the class interesting, thus enhancing their attention, because they could see what was inside the human body. They noted that the subject matter was easier to understand when one can actually view in color what specific anatomical structures look like. This attitude is expressed in the following quote from a student's critique:

> I found this (the audio-visual module) to be very interesting over the book (the programmed text). I would suggest that this be used, with the idea of the student being able to see and hear closer to life examples, to place and remember items better.

On the negative side, a majority of students thought that the pace of the audio-visual module was too rapid. However, many claimed that they still managed to grasp the material because the speed of the presentation increased their attentiveness. Some students expressed the view that too many medical terms appeared on the slides, thus increasing their complexity. This may have interfered with their efforts to associate an anatomical structure with its corresponding nomenclature. Also, a few trainees expressed their concern over not being able to ask any questions during the sound-slide program; but they acknowledged that this is also true when they responded to the written program. In summary, practically all students had more favorable attitudes toward the audio-visual programmed module than toward the programmed text. It should be noted here that student attitudes toward programmed materials may bear little relation to the teaching effectiveness of those materials (Eigen, 1963; Hough & Revoir, 1963; Vernon, 1953).

15

IV. DISCUSSION

The findings of this study support the conclusions of many previous investigations and substantiate several psychological theories of training. Stating this rather conservatively, some programmed texts use some repetition of words, phrases, and principles. Also, some of these books require learners to repeat programs until they have achieved mastery. The results of this and other investigations (Valverde & Morgan, 1968) suggest that such repetition hardly seems necessary. For example, Valverde and Morgan found that by eliminating the usual redundancy in a linear programmed text on medical terminology, equivalent achievement was attained by Air Force enlisted trainees using a minimally redundant linear program, a brief narrative of the same information, and a study card which presented essential medical prefixes, suffixes, and stems. They concluded that excessive programmed practice may detract from the effectiveness of a self-instructional program. In many cases lean programs seemed to be more economical and efficient than programs which contained redundant material. Whether these effects were produced by the nature of the instructional material itself, or by the interaction between the instructional material and motivational factors, is difficult to interpret. However, considering the student reactions in this study, the motivational aspect appears to be a significant factor in accounting for the effectiveness of the experimental audio-visual module. Motivation is also given primary importance in McDonald's (1961) theoretical analysis of audio-visual programmed materials. He did not deny that audio-visuals might serve as specific instructional tools; but he attached more importance to their motivating value in arousing the interest of students, and in directing their attention to the more salient aspects of a subject. McDonald also stressed the importance of using audio-visuals properly to create learning sets or to orient the student in the right direction.

The results of this investigation can be interpreted from another point of view. Most Skinnerian programmers believe that linear steps should be gradual enough so that errors in responding rarely occur. Galanter (1959) suggested that the error rate should be below ten percent. Using easy programmed texts made up of very small steps, like the chapter on the digestive system, has revealed what Rigney and Fry (1961)

have called the "pall effect": the boredom induced by such material, especially in bright students. According to the contents of the student critiques, this effect manifested itself in this study. Several characteristics of linear programs, stated Rigney and Fry, contribute to their implicit tedium. Most obvious is the repetition that is deemed necessary to teach material in this fashion. Apparently, practically all analyses of Skinnerian programming stress the importance of repetition. A typical comment was the one made by Smith (1959): "If there are several ways to say the same thing, use them all. Redundancy is required." A second characteristic of written linear programs, remarked Rigney and Fry, that make them seem dull and lifeless is the deliberate simplicity of each frame. Programmers proceed on the assumption that any portion of an item which is not necessary for the student to arrive at the correct answer should be deleted. Smith asserted, "Eliminate all irrelevancies except contrived anticipators." Frames designed in this manner may lead the learner directly to the response desired by the programmer, but they do little to stimulate to learner's interest in the larger aspects of the subject matter. A third deadening feature of Skinnerian programs, according to Rigney and Fry, is the contrived artificiality of their structure. Air Force trainees, for example, attempting to get some understanding of a complex subject matter deserve more than the verbal and mechanical artifices of a typical linear program. The tiny bits of information doled out in discrete steps, the verbal and grammatical tricks, the mechanical prompts all seem calculated more to frustrate students than to enlighten them. These techniques, along with the other devices that structure a written linear program, tend rather to obscure meaningful interrelationships than to clarify them. As affirmed by Rigney and Fry, "It is a very real danger that the student plodding through a linear program will not be able to see the forest for the trees."

The results of this research can be seen from another perspective which is implied by the immediately preceding comments. Skinnerian operant conditioning principles and methods, that appear to work so successfully in training animals, are assumed to apply to human learning as well. The assurance with which the Skinnerian theorists apply their animal training techniques to the complexities of human behavior was illustrated by Holland (1960): "This principle of gradual progression runs through many of the teaching machine techniques. But human and avian scholars deserve the same careful tutorage." This Skinnerian programmed approach proposed to revolutionize education by leading learners through a carefully arranged series of small steps from ignorance to mastery, while they seldom if ever encounter failure. According to Smith and Smith (1966), if one endeavors to weigh Skinnerian concepts on their psychological merits, one discovers firstly

> ....there are obvious things to be said about the pigeon analogy. People are not pigeons. They do not ... except under certain restricted circumstances–learn like pigeons. [Secondly], the complex sequence ... used to shape the behavior of a laboratory pigeon has no inherent structure and organization except in the thinking of the experimenter and ... thus has no adaptive function for the pigeon that learned it except under the artificial and arbitrary arrangements of the operant conditioning laboratory. In contrast, the sort of behavior taught to human students in school is meaningful to people in general, serves adaptive purposes in a variety of situations in school and out, and is subject to confirmation and correction by the way it falls into place within the larger area of human knowledge and experience (p. 289).

It does not seem likely that the principles of learning which describe the behavior of animals in laboratories can be extrapolated to humans in training environments. Then again, a resourceful teacher probably never learned his communicative skills in an animal laboratory (Quinn, 1963). A linear programmed text tends to focus its attention exclusively on the articulation of material in terms of the amount of detail. In so doing, it establishes no general context or frame of reference. Some of the meaning and significance of a subject cannot help but be lost due to its being mechanically presented in a series of discrete steps. Consequently, it would appear to be almost impossible for a linear written program to teach trainees the broader aspects of anatomy and physiology.

Needless to say, the teaching effectiveness of Skinnerian programmed texts was questioned by this study; it was also doubted by Homme and Glaser (1960). They reported instances in their experimental work on programmed materials when the correct answers were inadvertently omitted. Much to their surprise, the subjects sometimes insisted that the omission made no difference. To these learners, extrinsic confirmation of correctness was not always necessary. Also, no external reinforcement was precisely contingent upon their responses; yet, they learned the materials. The implications of this, expounded Homme and Glaser, are that no one had pinned down the exact nature of the reinforcement in self-instruction, and

that at times subjects had learned even without specific reinforcements. As evidenced by the Air Force medical trainees used in this study, students are often too impatient to wait around to have their behavior shaped bit by bit. A learner who understands the material well often resents the slow pace imposed by this procedure. This is especially true if the new subject matter is meaningful and fits well into their present frame of reference.

It seems that Skinnerian programs are too inflexible to do justice to human capabilities in learning. Written linear programming tends naturally toward an educational regimentation that does not make adequate allowances for the differences that exist among learners, among their teachers, and among the subjects to be taught. Nor does a linear programmed text take advantage of the many channels of communication that can be used in instruction (Smith & Smith, 1966). By dictating the same sequence of responses for all learners, a program that serves the needs of a relatively dull or uninformed individual becomes a drag on a learner who is better equipped. According to Smith and Smith, Skinnerian programmers have made much of what they call self-paced instruction. In reality, however, writing out many discrete responses makes it impossible for bright students to move ahead at a rate commensurate with their ability. It should be emphasized that not only do programmed texts fail to make allowances for individual differences among students, but also they provide a very poor medium for expressing individual differences among instructors. The programmer now becomes the voice of authority and shapes the behavior of the learner along prescribed pathways. As Jordan (1963) stated, Skinnerian programs by no means teach by the Socratic method, but are completely authoritative.

V. CONCLUSIONS AND RECOMMENDATIONS

1. This study demonstrated that the 20-minute minimally redundant audio-visual program was as effective as the written program, which required anywhere from 80 to 120 minutes to complete, for teaching Air Force enlisted medical trainees the rudiments of the digestive system. Thus, a substantial reduction was realized in the amount of training time needed to bring students to levels of achievement which did not differ.

2. This investigation indicated that AFQT subgroups defined on the basis of high and low scores did not differ in their level of performance measured by the posttest. It found that high and low AFQT students who observed the audio-visual module did not differ in their degree of attainment from the high and low AFQT students who completed the programmed chapter. It was concluded that trainees who differed somewhat in their basic abilities to learn as measured by the AFQT acquired as many facts about the digestive system from watching the audio-visual program as from interacting with the written program.

3. This research determined that the subgroups defined on the basis of high and low Wk-1 Anat&Phys scores did not differ in their posttest performance. Furthermore, it demonstrated that high and low Wk-1 Anat&Phys subjects who had seen the audio-visual module did not differ in their level of achievement from the high and low Wk-1 Anat&Phys subjects who had responded to the programmed text. It was deduced that trainees who differed somewhat in their mastery of the rudiments of anatomy, physiology, and medical terminology, as measured by the Wk-1 Anat&Phys test, manifested as much knowledge about the digestive system after the audio-visual instruction as they did after the written programmed instruction.

4. From the sampled student reactions and opinions toward the audio-visual and the written linear programs for teaching the digestive system, it was revealed that medical trainees liked viewing the audio-visual program better than using the written program. This was so, students claimed, because the text was very monotonous and tedious. Also, the trainees asserted that the audio-visual module went directly to the point of what should be learned, and that it was more interesting than the programmed text. Consequently, the audio-visual programmed instruction helped them to attend to and to retain the material more easily than the written programmed instruction. Negatively, many trainees thought that the pace of the audio-visual module was too rapid. Some students expressed concern over the complexity of some of the slides, and over not being able to ask any questions during the sound-slide showing. Most students, however, had more favorable attitudes toward the audio-visual module than toward the programmed text.

5. In light of the findings, it was recommended that utilization of audio-visual programs be maximized and utilization of written programs be minimized within the Medical Service Fundamentals Course.

REFERENCES

Borgatta, E.F., & Corsini, R.V. *Quickword test manual,* New York: Harcourt, Brace and World, 1964.

Briggs, C.E., & Naylor, V.C. The relative efficiency of general training methods as a function of transfer task complexity. *Journal of Experimental Psychology,* 1962, **64,** 505-512.

Campell, D.T., & Stanley, J.C. Experimental and quasi-experimental designs for research on teaching. In N.L. Gage (Ed.), *Handbook of research on teaching.* Chicago: Rand McNally, 1963.

Deese, J. Comment and summary: A mine of possible applications. *Audio-Visual Communications Research,* 1961, **9** (5), 79-87.

Eigen, L.D. High-school student reactions to programmed instruction. *Phi Della Kappan,* 1964, **44,** 282-285.

Galanter, E. The ideal teacher. In E. Galanter (Ed.), *Automatic teaching: The state of the art.* New York: Wiley, 1959.

General Programmed Teaching Corporation (GPTC). *The human body and its functions: A programmed course.* Chicago: Encyclopedia Britannica Press, 1964.

Guilford, J.P. *Fundamental statistics in psychology and education.* New York: McGraw-Hill, 1965.

Holland, J.G. Teaching machines: An application of principles from the laboratory. In A.A. Lumsdaine and R. Glaser (Eds.), *Teaching machines and programmed learning: A source book.* Washington, D.C.: National Education Association, 1960.

Homme, L., & Glaser, R. Problems in programming verbal learning sequences. In A.A. Lumsdaine and R. Glaser (Eds.), *Teaching machines and programmed learning: A source book.* Washington, D.C.: National Education Association, 1960.

Hough, J.B., & Revoir, B. Programmed instruction at the college level: A study of several factors influencing learning. *Phi Della Kappan,* 1963, **44,** 286-291.

Jordan, J.A. Socratic teaching. *Harvard Educational Review,* 1963, **33,** 96-104.

Kendler, H.H. Teaching machines and psychological theory. In E. Galanter (Ed.), *Automatic teaching: The state of the art.* New York: Wiley, 1959.

Kendler, H.H. Stimulus-response psychology and audio-visual education. *Audio-visual Communications Review,* 1969, **9** (5), 33-41.

Krumboltz, J.D., & Weisman, J.G. The effect of overt vs. covert responding to programmed instruction on immediate delayed retention. *Journal of Education Psychology,* 1962, **53,** 89-92.

Lindquist, E.F. *Design and analysis of experiments in psychology and education.* Boston: Houghton Mifflin, 1956.

McDonald, T.J. Motivation and the communication processes. *Audio-visual Communications Review,* 1961, **9** (5), 57-67.

Nunn, G. An English teacher looks at programmed learning. *Audio-visual Instruction,* 1961, **6,** 141-142.

Pressey, S.L. Teaching machine (and learning theory) crisis. *Journal of Applied Psychology,* 1963, **47,** 1-6.

Quinn, A.K. How to program (in 10 difficult lessons). *Audio-visual Instruction,* 1963, **8,** 80-83.

Rigney, J., & Fry, E. Current teaching-machine program and programming techniques. *Audio-visual Communications Review,* 1961, **9** (3).

Skinner, B.F. Science of learning and the art of teaching. *Harvard Educational Review,* 1954, **128,** 86-97.

Skinner, B.F. Teaching machines. *Science,* 1958, **128,** 969-977.

Smith, D.E.P. Speculations: Characteristics of successful programs and programmers. In E. Galanter (Ed.), *Automatic teaching: The state of the art.* New York: Wiley, 1959.

Smith, K.U., & Smith, M.F. *Cybernetic principles of learning and educational design.* New York: Holt, Rinehart, and Winston, 1966.

Valverde, H., & Morgan, R. *Influence on student achievement of redundancy in self-instructional materials.* AMRL-TR-68-75, Wright-Patterson AFB, Ohio: Aeromedical Research Laboratory, 1968.

Vernon, M.D. Perception and understanding of instructional television programs. *British Journal of Psychology,* 1953, **44**, 116-126.

APPENDIX I. SCRIPT OF THE AUDIO-VISUAL MODULE PROGRAMMED TO TEACH THE RUDIMENTS OF THE DIGESTIVE SYSTEM

The slides that you are about to see, and the recording that you are now listening to, will cover the digestive system. Chapter 7 in your programmed anatonomy and physiology text also presents this system. Let us examine, for a short while, the essentials of this system without the aid of your text.

Slide 1 This slide gives you a clear look at all of the organs and glands that make up the digestive system. You will notice that all structures have been numbered but not in any order. There are several structures that are not a part of the digestive system, but their relationships to this system must and will be explained. Starting with the left portion of the slide, let's look carefully at the shape and location of each structure and name it.

First we have the starting point of this digestive system, number 2 or the mouth. In the mouth or oral cavity, we find the teeth and the tongue.

Number 3 points to a lid-like structure, not a part of this system, that we call the epiglottis. Spelled EPIGLOTTIS. The epiglottis forms a covering over the windpipe when food is being swallowed.

Number 6 is the windpipe that we just mentioned. Medical name is the trachea. Spelled TRACHEA. Number 7 points to the liver and notice if you will, the size of the liver, much larger I'm sure than most people realize.

Number 11 points to a small organ just under the liver. Its name is the gallbladder. Spelled GALLBLADDER.

Number 12 points to the small intestines.

Number 13 to the appendix. Spelled APPENDIX. It projects inferiorly from the large intestine, near where the large and small intestines are joined.

Number 14 is the rectum. Spelled RECTUM. The openings of the rectum and the very end of this system are called the anus.

Moving now to the right side of our slide we see number 1 which points to the three glands that we collectively call the salivary glands. Spelled SALIVARY.

Number 5 points out the foodpipe or esophagus. Spelled ESOPHAGUS.

Number 8 is the stomach.

Number 9 the gland located behind the stomach - the pancreas. Spelled PANCREAS.

Number 10 points out the very first loop of the small intestine. It is called the duodenum. Spelled DUODENUM, also pronounced Duochenum.

Number 15 labels the large intestines.

Now, as I call out the number, I want you to respond with the correct medical name. Ready?

All right,

2

Correct - the mouth is the beginning of the Digestive System, and it's here in the oral cavity that we have 2 other organs of digestion - the teeth and the tongue.

1

Correct - the salivary glands.

4

Right - the back of the throat is the pharynx.

20

5

That is correct - the esophagus or foodpipe are one in the same.

8

Right, the stomach.

12

Yes, you are right. It's the small intestine.

10

The word is pronounced either duodenum or duochenum.

15

Right, the large intestine.

13

The appendix is correct.

14

Correct, the rectum is the last portion of the large intestine.

7

That's correct, the liver.

11

Right, the gallbladder lies under the liver.

9

Very good, the answer is the pancreas.

The overall function of this digestive system, as I'm sure you realize, deals with food, and involves the ingestion and digestion, absorption and elimination of food.

Slide 2 As you can see by this slide, the main organs of the digestive system form a tube. This tube, that starts with the mouth and ends with the anus, is called the alimentary tract or alimentary canal. Spelled ALIMENTARY. Looking very closely at this slide - let me name the main organs of the alimentary canal in their correct order:

First, there's the mouth, then the pharynx (they are not shown on this slide), next comes the esophagus, the stomach and then the intestines, both small and large.

Slide 3 Let's review now, in general detail, these main organs of digestion and discuss their individual functions. The mouth is the beginning or proximal end of this system and tube. Here, in the oral cavity, food enters the alimentary canal under voluntary control.

Slide 4 After the mouth comes the throat or pharynx. It's here that voluntary control of food is lost and involuntary reflex action occurs by way of peristalsis. Spelled PERISTALSIS. Peristalsis is the involuntary rhythmical muscular movement that propels food through the alimentary canal.

The pharynx is a passageway for foods between mouth and esophagus. The esophagus or foodpipe is the next organ in line, and is a passageway for foods between pharynx and stomach. It lies behind or posterior to the trachea.

Slide 5 The stomach is an internal organ and you may recall from your muscular system, that smooth muscle in flat layers or sheets is found in internal organs. This slide is a good picture of just that.

Slide 6 This slide gives you some idea of the shape and internal structure of the stomach with the esophagus opening into the upper portion and the duodenum coming off of the latent-inferior part. Here, food is put through a churning action and partial digestion occurs with the production of gastric juice. Here's a bit of nice-to-know information. Drugs and alchohol are readily absorbed in the lining of the stomach.

Slide 7 The intestines, both small and large, form the last part of the alimentary canal. In this slide we see most of the small intestines but part of the large is visable also. The first intestines that we encounter after the stomach are the small intestines. Most digested food absorption takes place here.

Slide 8 The very first portion of the small intestine is called the duodenum. This slide shows just the duodenal loop.

Slide 9 Here we see the duodenum in relationship with other structures in that area. This loop is very important because many digestive juices enter the alimentary tract at this point, digestive juices such as pancreatic and bile.

Slide 10 Here in this slide is pictured the large intestine, including the last seven or eight inches, called the rectum. It's in the large intestine that most water absorption takes place, along with elimination of body water. Also in this slide, the appendix is visible, located near the junction of the small and large intestine. It has no known function.

That completes our coverage of the main organs of digestion and before we turn our attention to the accessory organs of digestion, there are several important points that must be made.

Slide 11 First of all, there are two types of digestion, mechanical and chemical. Mechanical digestion covers all the physical changes in food, and the movement of foods in the alimentary canal. Chemical digestion is concerned with all the chemical changes that occur to foods in the canal.

Slide 12 The first three (carbohydrates, proteins, fats) listed here must be changed chemically before the body can make use of them. The last three (vitamins, minerals, and water) do not have to be chemically changed.

Slide 13 Here we make a statement that we hope will simplify this system a little more, so that you will gain a quicker understanding. The main point is that digestive juices must be secreted if a chemical change is to take place. In the digestive juices we find certain substances call enzymes. Spelled ENZYMES. Enzymes must be present for chemical action if change is to occur.

Slide 14 This definition of the word metabolism is not difficult to understand. The body must use or utilize foods to remain healthy and alive. This utilization of food for heat, energy, growth and repair is called metabolism.

Slide 15 Carbohydrates and fats are both needed by the body, primarily to supply heat and energy.

Slide 16 Proteins are necessary for growth and the repair of body tissue.

Slide 17 Vitamins, minerals, and water are essential for the life processes, such as growth, energy production, reproduction, and resistance to disease.

Now with these points fresh in our minds, we can better understand the functions of the accessary organs of digestion.

Slide 18 The first of the accessary organs happens to be the salivary glands. This slide shows us where they are generally located. The salivary glands secret saliva which aids in the digestion of carbohydrates. The teeth and tongue both are considered accessary organs and are located here in the oral cavity. The function of the teeth in the oral cavity. The function of the teeth is primarily the chewing of foods. The tongue aids the swallowing of foods.

Slide 19 Gastric or stomach juice, secreted by the stomach, is concerned with digestion of proteins.

Slide 20 The liver, as pictured here, covers a good part of the abdominal area. It is the largest gland in the body. Digested foods, as they are taken into the blood, are carried by the blood directly to the liver.

Slide 21 The liver has many, many jobs to perform but its prime function is manufacturing and secreting a substance called bile. Bile is necessary for the "breaking-up" of fats, and comes in contact with food in the duodenum.

Slide 22 Here we see the relationships of the liver with the duodenum, and most importantly the storage shed for bile, the gallbladder. Bile is made and secreted by the liver but stored by the gallbladder.

Slide 23 This slide shows the last accessary organ that we will discuss, the pancreas. The pancreas secrets a pancreatic digestive juice which aids in the digestion of starches and completes the digestion of fats. Remember bile breaks up fat but complete digestion is left up to the pancreatic juice. Proteins are partially digested by this pancreatic juice.

Slide 24 This slide shows the location of the pancreas, which is behind the stomach and its relationship with other structures in that area.

The accessory organs of digestion are listed as the teeth, tongue, salivary glands, liver, gallbladder and pancreas.

Slide 25 Now in review, follow along with me as I again name the structures of the digestive system and explain their functions.

Number 2: mouth, oral cavity, teeth and tongue

Number 1: salivary glands

Number 4: pharynx

Number 5: esophagus

Number 8: stomach

Number 12: small intestine

Number 10: duodenum

Number 15: large intestine

Number 14: rectum, anus

This completes our discussion of the digestive system.

APPENDIX II. PRETEST

Fifty percent of the test covered the first six chapters of the programmed text (The Organization of the Human Body, The Skeletal System, The Muscular System, The Nervous System, The Circulatory System, and The Respiratory System), and 50 percent covered Chapter Seven (The Digestive System).

1. Another name for bone growth is the process of
   a. bone development.
   b. ossification.
   c. marrow production.
   d. calcium composition.

2. Arterioles and venules are connected by
   a. veins.
   b. vesicles.
   c. ureters.
   d. capillaries.

3. Deep sleep is a result of complete _____ dominance.
   a. parasympathetic
   b. CNS
   c. ANS
   d. sympathetic

4. The function of the nervous system is to control the
   a. flow of information in our brains.
   b. movements of smooth muscle.
   c. activities of our body.
   d. prevention of serious injury or damage to the body.

5. The three main parts of the skeletal system are
   a. muscles, ligaments, and bones.
   b. bones, joints, and ligaments.
   c. joints, bones, and cartilage.
   d. bones, cartilage, and muscles.

6. The eyeblink and the hiccough are examples of
   a. reflexes.
   b. stimuli.
   c. contraction.
   d. nervousness.

7. A function of the skeletal system that is provided by bone marrow is
   a. holding two bones together.
   b. support of the body.
   c. movement of muscles.
   d. production of blood cells.

8. The fluid portion of blood is called
   a. corpuscles.
   b. plasma.
   c. lymph.
   d. hemolysin.

9. Which of the following is <u>not</u> a function of the skeletal system?
   a. blood cell production
   b. protection of internal organs
   c. support of the body
   d. supplying body cells with O_2

10. When a neural impulse travels from one neuron to another, this event is called a
    a. synthesis.
    b. synapse.
    c. syndyne.
    d. synopsis.

11. The walls of various internal organs contain layers of _____ muscle.
    a. smooth
    b. long
    c. short
    d. free

12. The two main units of the CNS are the
    a. receptors and axons.
    b. nerves and muscles.
    c. efferents and dividers.
    d. spinal cord and brain.

13. Nutrients pass from the blood vessels to body cells through
    a. tympanic antrums.
    b. capillary walls.
    c. metabolic action.
    d. aortic venae.

14. A group of tissues united or arranged to perform a specific function is called a(n)
    a. cell.
    b. organ.
    c. bone.
    d. system.

15. What controls the direction of blood flow within the heart?
    a. aorta
    b. valves
    c. ventricles
    d. atria

16. The way a cell is organized permits certain materials to enter and leave through _____ in the membrane.
    a. breaks
    b. windows
    c. entrances
    d. pores

17. The muscle controlling lung action is called the
    a. iliacus.
    b. trapezius.
    c. diaphragm.
    d. supinator.

18. Inhaled air passes from the nose or mouth into the
    a. soma.
    b. pharynx.
    c. esophagus.
    d. trachea.

19. Which blood vessels carry blood away from the heart?
    a. veins and arteries.
    b. veins and venules.
    c. arteries and arterioles.
    d. ventricles and veins.

20. The sensitive end of a sensory neuron is called a(n)
    a. receiver.
    b. autonomer.
    c. developer.
    d. receptor.

21. Any change in the environment detected by a receptor is called a(n)
    a. stimulus.
    b. alveolus.
    c. stereobus.
    d. simulance.

22. The heart is composed of what type of tissue?
    a. cardiac
    b. osseous
    c. cartilaginous
    d. ventricular

23. The nervous system becomes aware of what is happening inside and outside the body by way of
    a. sensitive axons.
    b. sensory neurons.
    c. sensational interstices.
    d. sensamatic impulses.

24. The smallest organized unit of the nervous system is the
    a. acton.
    b. axon.
    c. neuron.
    d. neurose.

25. The ANS serves to control most of the _____ activity of the body.
    a. responsive
    b. generative
    c. unlearned
    d. motor

26. The pharynx is near what point of the digestive system?
    a. lateral
    b. proximal
    c. extensive
    d. distal

27. Three substances which undergo chemical digestion are
    a. fats, proteins and minerals.
    b. proteins, vitamins and minerals.
    c. vitamins, carbohydfates and proteins.
    d. carbohydrates, proteins and fats.

28. Which of the following is not a part of the tube called the alimentary canal?
    a. mouth
    b. larynx
    c. pharynx
    d. stomach

29. The trachea is _____ to the esophagus?
    a. anterior
    b. inferior
    c. posterior
    d. superior

30. The esophagus is a food passageway between the _____ and _____.
    a. throat and pharynx
    b. esophagus and guts
    c. stomach and oral cavity
    d. pharynx and stomach

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31. The liver secretes an emulsifier that starts breaking action on?
    a. proteins
    b. fats
    c. carbohydrates
    d. minerals

32. At what point does bile and pancreatic juice first enter the alimentary canal?
    a. duodenum
    b. stomach
    c. esophagus
    d. colon

33. The two types of digestion are: mechanical and gastric
    a. true
    b. false

34. The teeth, tongue and salivary glands are found in the _____ cavity.
    a. duodenum
    b. digestive
    c. abdominal
    d. oral

35. Physical movement of foods is part of the?
    a. mechanical digestion
    b. physical digestion
    c. accessory digestion
    d. chemical digestion

36. The rectum is near the _____ end of its respective system.
    a. medial
    b. proximal
    c. distal
    d. progressive

37. The large intestines are concerned with the absorption of?
    a. alcohol
    b. water
    c. drugs
    d. food

38. Foods passing distal to the pharynx are under what kind of control?
    a. voluntary
    b. entension
    c. involuntary
    d. non-voluntary

39. Proteins aid in tissue repair.
    a. true
    b. false

40. Metabolism is concerned with?
    a. body's ability to utilize foods
    b. tissue production
    c. energy distribution
    d. function operation

41. The pancreas is located posterior to the?
    a. kidneys
    b. esophagus
    c. stomach
    d. large intestines

42. The gallbladder stores _____.
    a. insulin
    b. bile
    c. pancreatic juice
    d. fats

43. Pancreatic digestive juice completes the digestion of _____?
    a. carbohydrates
    b. proteins
    c. fats
    d. bile

44. The main organs of digestion are?
    a. mouth, pharynx, esophagus, stomach, intestines
    b. throat, foodpipe, stomach, intestines
    c. mouth, throat, stomach, small intestines
    d. oral cavity, abdominal canal, anal canal

45. The first 10 inches of the small intestines is the?
    a. duodenum
    b. trachea loop
    c. pancreas canal
    d. bile duct

46. Food is moved through the esophagus, stomach and intestines by
    a. alistalsis
    b. peristalsis
    c. motostalsis
    d. musculostalsis

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47. Carbohydrates are used by the body to
    a. build new tissues
    b. build new chemical substances
    c. provide heat and energy
    d. repair new tissues

48. The alimentary canal is part of the
    a. circulatory system
    b. respiratory system
    c. nervous system
    d. digestive system

49. Bile is produced and secreted by the liver.
    a. true
    b. false

50. What is the largest gland in the body?
    a. pancreas
    b. gonads
    c. liver
    d. salivary

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APPENDIX III. POSTTEST

All of the test covered the Digestive System.

1. What structure identifies the most proximal point of the digestive system?
   a. mouth
   b. pharynx
   c. nasal passage
   d. esophagus

2. The food passageway between the pharynx and stomach is the
   a. throat
   b. esophagus
   c. duodenum
   d. bile duct

3. Name the two types of digestion
   a. physical and mechanical
   b. traumatic and physical
   c. chemical and movement
   d. mechanical and chemical

4. Carbohydrates and fats are needed by the body for what reason?
   a. heat and energy
   b. muscle repair
   c. endurance
   d. metabolism

5. Pancreatic juice first enters which part of the alimentary canal?
   a. stomach
   b. duodenum
   c. bile duct
   d. colon

6. Which of the following secretes an emulsifier of fats?
   a. liver
   b. stomach
   c. pancreas
   d. salivary glands

7. There are three accessory organs found in the oral cavity. Name them.
   a. gastric, tongue, glands
   b. teeth, pharynx, nasal
   c tongue, food passageway, teeth
   d. teeth, tongue, salivary glands

8. The largest gland in the body is the
   a. spleen
   b. liver
   c. pancreas
   d. pharynx

9. The movement of food along the alimentary canal is part of
   a. physical digestion
   b. chemical digestion
   c. mechanical digestion
   d. both b & c are correct

10. Food passing through the alimentary canal distal to the pharynx is under _____control
   a. voluntary
   b. involuntary
   c. both a & b
   d. neither a or b

11. The anus is at the _____end of its respective system
   a. distal
   b. medial
   c. proximal
   d. digestive

12. Most water absorption occurs in the
   a. stomach
   b. duodenum
   c. large intestine
   d. small intestine

13. Tissue repair in the body is accomplished by
   a. minerals and water
   b. proteins
   c. carbohydrates and fats
   d. vitamins

14. The body's ability to utilize foods is called
   a. peristalsis
   b. digestionalism
   c. metabolism
   d. utilization

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15. The gland located behind the stomach is the
    a. duodenum
    b. gallbladder
    c. salivary
    d. pancreas

16. Vitamins, minerals and water are necessary for
    a. life processes
    b. movement of foods
    c. chemical absorption
    d. energy production

17. The pharynx is a passageway between the mouth and the
    a. esophagus
    b. windpipe
    c. trachea
    d. duodenum

18. What organ has the specific function of producing bile?
    a. pancreas
    b. gallbladder
    c. trachea
    d. liver

19. What substance completes the digestion of fats?
    a. liver
    b. bile
    c. gallbladder
    d. pancreatic digestive juice

20. Gastric juice is secreted by the
    a. liver
    b. mouth
    c. tongue
    d. stomach

21. The organ that stores bile is the
    a. gallbladder
    b. duodenum
    c. bile duct
    d. liver

22. The accessory digestive organs are
    a. teeth, tongue, salivary glands, pancreas, liver, gallbladder
    b. teeth, tongue, salivary glands, spleen, liver, gallbladder
    c. teeth, salivary glands, spleen, pancreas, gallbladder, liver
    d. tongue, spleen, pancreas, gallbladder

23. Bile is secreted by the
    a. duodenum
    b. pancreas
    c. gallbladder
    d. liver

24. The alimentary canal is part of the
    a. circulatory system
    b. respiratory system
    c. digestive system
    d. nervous system

25. Duodenum is the name given to a part of the
    a. large intestines
    b. pancreas
    c. stomach
    d. small intestines

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APPENDIX IV. SUPPLEMENTARY STATISTICAL TABLES

Table 8. **Means and Standard Deviations of Test Scores Available for Trainees**
(N = 112)

Test	Mean	SD
Posttest	19.5804	3.3521
AFQT	62.7053	14.4131
AQE Gen	74.7321	10.5659
AQE Admin	70.9911	14.1868
AQE Mech	58.7232	23.2251
AQE Elec	66.9018	17.4122
Wk-1 Anat&Phys	46.4553	9.1039
Quickword	68.9375	14.0579

Note.—Pretest statistics were excluded from this particular table since not all subjects were given this test; these statistics are presented later in the report. The AFQT and the four AQE scores were available in percentiles only; consequently, the means and standard deviations reported for these tests are percentile statistics.

Table 9. **Correlation Matrix of Test Scores**

Test	Post-test	AFQT	AQE Gen	AQE Admin	AQE Mech	AQE Elec	Wk-1 Anat&Phys	Quick-word
Posttest	-	.255	.401	.246	.285	.315	.516	.242
AFQT		-	.401	.223	.455	.472	.306	.113
AQE Gen			-	.500	.668	.699	.471	.216
AQE Admin				-	.195	.431	.274	.234
AQE Mech					-	.727	.376	.093
AQE Elec						-	.342	.287
Wk-1 Anat&Phys							-	.111
Quickword								-

Note.—$r \geq .260$ is significant at the .01 level, df = 110. For computing this correlation matrix and subsequent multiple correlation and analyses of covariance, it was postulated that the transformation from test raw scores to percentile scores was linear. At worst, reported correlations were underestimated.

Table 10. **Summary of the Wherry-Doolittle Method for Computing Multiple Correlation, Criterion Variable: Posttest**

Step Number	Predictor Entered	R	R^2	Increase in R^2	F Value to Remove
1	Wk-1 Anat&Phys	.5158	.2661	.2661	39.8838
2	Quickword	.5483	.3007	.0346	5.3865
3	AQE Gen	.5678	.3224	.0218	3.4698
4	AFQT	.5696	.3245	.0020	.3231
5	AQE Mech	.5698	.3246	.0002	.0262

Note.—For R = .5698; SE of EST = 28.1900; MS Regression = 8098.074; F(5,106) = 10.190; $p < .001$. A predictor variable was added or removed from the regression equation according to the following three rules: (1) if there were one or more predictors in the regression equation whose F value was less than .005, the one with the smallest F value was removed; (2) if no predictor is removed by (1) and there were one or more predictors not in the regression equation which had tolerance values greater than or equal to .001, the one with highest F value among all predictors was added; and (3) if no predictor was removed by (1) or added by (2) and there were one or more predictors not in the regression equation which passed the tolerance test, the one with highest F value greater than F to enter, .01, was added.

Table 11. **Regression Coefficients and Their Respective t Values for Test Concomitants to Posttest Performance, Factors: Pretest and Programmed Medium**

Test	AFQT	AQE Gen	AQE Mech	Wk-1 Anat&Phys	Quick-word
Regression Coefficient	.0203	.0461	−.0111	.1147	.0611
Computed t Values	.8941	1.1498	−.6341	3.0755*	2.6352*

Note.—MS Regression = 6.6882; F(5, 75) = 7.5357; $p < .001$.
*$p < .01$; df = 75.

Table 12. **Regression Coefficients, Standard Errors, and t Values for the Multiple Concomitant Variables Used in the One-way Analysis of Covariance, Reported for Total Source of Variation**

Covariate	Regression Coefficient	SE	t Value
AFQT	.0512	.0335	1.5273
AQE Gen	−.0320	.0459	−.6971
AQE Admin	.0445	.0292	1.5272
Pretest	.1280	.0832	1.5384
Wk-1 Anat&Phys	.0987	.0513	1.9221

Note.—None of these t values are significant at the .01 level, df = 43. This analysis was computed using test scores obtained from subjects in Classes 1 (n = 25) and 2 (n = 20) only. One subject's set of scores had been carelessly omitted from this analysis, hence the discrepancy in the N reported for Class 2 here and in Table 1.

Table 13. **Regression Coefficients and Their Respective t Values for Tests Concomitant to Posttest Performance, Factors: AFQT and Programmed Medium**

Test	AQE Gen	Wk-1 Anat&Phys	Quickword
Regression Coefficient	.0506	.1113	.0649
Computed t Value	1.2221	2.8616*	1.9527

Note. — MS Regression = 7.6670; F(3, 73) = 9.3975; $p < .001$.

*$p < .01$; df = 73.

Table 14. **Regression Coefficients and Their Respective t Values for Tests Concomitant to Posttest Performance, Factors: Week-One Anatomy and Physiology Test and Programmed Medium**

Test	AFQT	AQE Gen	Quickword
Regression Coefficient	.0181	.0606	.0720
Computed t Value	.8473	1.7036	2.1873*

Note. — MS Regression = 7.9293; F(3, 85) = 4.6314; $p < .01$.

*$p < .01$; df = 85.

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13. ABSTRACT

This study evaluated the learning efficiency and effectiveness of teaching an anatomical and physiological system to Air Force enlisted trainees utilizing an experimental audio-visual programmed module and a commercial linear programmed text. It was demonstrated that the audio-visual programmed approach to training was more efficient than and equally as effective as the programmed text approach to training. It was determined that trainees of different learning abilities acquired as much knowledge about the digestive system from viewing the 20-minute audio-visual module as from interacting for 80 to 120 minutes with the programmed text. It was established that students who differed in their mastery of the rudiments of anatomy, physiology, and medical terminology performed equally well after audio-visual instruction or after written programmed instruction. It was found that trainees reported more positive reactions to the audio-visual program than to the written program. It was recommended that within the Medical Service Fundamentals Course audio-visual programmed instruction be emphasized and written linear programmed instruction be de-emphasized.

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